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PATENT SPECIFICATION

(54) FLAME AND SMOKE CONTAINMENT SYSTEM

(71) I, TADASHI HATTORI, a Japanese Subject, of 15-20, 1-chome, Kamon-cho, Kishiwada-shi, Osaka-fu, Japan, do hereby declare the invention for which I pray that a patent may be granted to me and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a flame and smoke containment system which isolates a fire starting area from neighbouring areas by means of fire curtains to check the spread of flame and smoke.

Fire doors, fire shutters and the like have been heretofore used for this purpose. But, usually made of metal, they had the possibility of injuring a person upon closure, or locking up persons left behind to death because they cannot be easily opened once closed.

An object of this invention is to provide a flame and smoke shutoff system which can cause no injury to a person.

Another object of this invention is to provide a flame and smoke shutoff system which permits any person left behind to escape easily from the isolated area.

According to the present invention there is provided a flame and smoke containment system for use in a room having a floor and a ceiling comprising, a container adapted to be mounted on the ceiling and provided with a cover pivotally mounted at the bottom thereof, a curtain normally stored in said container so as to hang from the ceiling when said cover is opened and being of a sufficient length to reach the floor and of a sufficient width to cover the entire width of a section in which to contain the flame and smoke, said curtain being constituted by a net or cloth made of non-inflammable material, foaming means causing foam to flow down said curtain, detecting means responsive to heat or smoke, means for opening said cover in response to the operation of said detecting means, whereby letting fall said curtain, and a normally closed valve adapted to open in response to the operation of said detecting means, and to allow a liquid to flow to said foam producing means to cause the latter to produce foam.

In order that the present invention may be more readily understood an embodiment thereof will now be described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 is a side view of a flame and smoke shutoff system according to the present invention with the curtain down,

Fig. 2 is a front view thereof,

Fig. 3 is another side view thereof with the curtain stored,

Fig. 4 is a sectional view taken along the lines A-A of Fig. 2,

Fig. 5 is a sectional view of a differential valve used therein,

Fig. 6 is a side view of a portion of the curtain, and,

Fig. 7 is a side view similar to Fig. 1 showing another embodiment.

Referring to the drawings, the numerals 1 and 2 designate the ceiling and floor, respectively, of a room or passage in which this system is installed. On the ceiling 1 is horizontally mounted a long, box-like container 3 of a length substantially equal to the width of a section to be isolated. The container 3 is closed at its bottom by a cover 4 which is mounted to pivot around a shaft 5 at one side of the container 3. The cover 4 forms a portion of the ceiling when closed.

The numeral 6 designates a fire curtain constituted by two lightweight, flexible nets (or coarse cloths) made of relatively or totally noncombustible material, such as glass fiber or stainless steel filament. Normally housed in the container 3 as shown in Fig. 3, the curtain 6 is of a sufficient

width to extend over the entire width of the section and is of a sufficient length to reach the floor 2. A uniform spacing is maintained between two nets by a plurality of spacers 7 extending horizontally, said spacers being steel square tube covered with a soft material, such as rubber to avoid injury to a person. As shown in Fig. 6, a disk 8 is bolted to each side of the spacer 7 with a net sandwiched. The spacers 7 also serve as a weight bar.

A horizontal plate 9 extends inwardly from one side wall of the container 3 and has a guide plate 10 extending upwardly from its inner end. The guide plate 10 cooperates with a partition 11 of L-shape section extending downwardly from the top wall of the container 3 to form a longitudinal slit 12 extending over the entire width of the section. The upper ends of the curtain nets are fixed to the inner end of the horizontal plate 9 and that of the partition 11, respectively.

At bottom of one side of the container 3 are provided a plurality of hydraulic cylinders 13 which have a rod 14 coupled to a pivot bar 15 which is pivoted to a shaft 16 projecting inwardly from the side wall of the container 3. The rod 14 is biased by a spring (not shown) to project inwardly and the pivot bar 15 normally engages the free end of the cover 4 to hold it closed. When the rod 14 is withdrawn by the hydraulic cylinder 13, the bar 15 disengages the cover 4, which pivots open under its own weight.

On the same side of the container 3 are mounted a plurality of pairs of foam producers 19 for blowing foam into the container 3. Each foam producer 19 is a bent pipe having a strainer 20, a nozzle 21 and three wire gauges 22 incorporated therein in this order. Opposed with their inlets facing to each other, each pair of the foam producers 19 is connected together by a blowoff pipe 25 which is connected to a supply pipe 17 through a branch pipe 26. A mixture of water and a foaming agent used as a gas containment liquid in the preferred embodiment is supplied from the supply pipe 17. Preferably, the foaming agent has a suitable viscosity.

After passing through the strainer 20, the mixture is jet fed from the nozzle 21, when air is sucked in from air inlet 23 around the nozzle. When the mixture strikes three wire gauges 22 in turn, a large amount of fine bubbles is formed and blown into a diffusion chamber 24 provided over the plate 9. Each foam producer 19 communicates with the diffusion chamber 24 through an opening 27 formed in one side wall of the container 3. The diffusion chambers are open at both ends thereof and have a plurality of perforations 28 formed in their bottom.

Upstream of the supply pipe 17 is arranged an automatic valve such as a differential valve 31 shown in Fig. 5. The latter has a diaphragm 32 attached to a valve body 33 which normally closes a valve hole 34 from above. This valve has a lower chamber 35 communicating with its inlet and an upper chamber 36 communicating with a solenoid valve 37 through an escape pipe 38. Between these two chambers is formed an orifice 39 over which a ball 40 is mounted to prevent the liquid from flowing from the upper chamber 36 back to the lower chamber 35. The pressure in the upper chamber 36 is adapted to be normally equal to that in the lower chamber 35 with the valve body 33 biassed by a spring 41 toward the valve hole 34.

In each fire-prevention section are provided an electrical smoke sensor 43 and a heat sensor 43 which operate to transmit an electrical signal upon the detection of smoke or gas over a predetermined concentration or a temperature above a predetermined level.

When the solenoid valve 37 opens in response to the signal, the pressure in the upper chamber 36 of the differential valve 31 sinks so that the liquid in the lower chamber 35 pushes up the valve body 33 with the diaphragm 32 against the bias of the spring 41 to open the valve hole 34. Thus the liquid flows through the differential valve 31 downstream.

A plurality of cords 29 wrap vertically around the curtain 6 to wind it up. Each cord has one end fixed to the underside of the plate 9 and the other end wound around a winding drum 30 mounted on the horizontal portion of the partition 11. The winding drum 30 may be operated either by hand or by a motor. As the drum 30 rotates to take up the cords 29, the curtain 6 is rolled up into the lower portion of the container 3 as shown in Fig. 3.

In operation, if a fire should start in a section in a room or a passage, the smoke or heat sensor 42 or 43 automatically operates to transmit an electrical signal to open the solenoid valve 37. Thus, the differential valve 31 opens to allow the liquid to flow to the branch pipes 26 and pipes 18 communicating with the hydraulic cylinders 13.

The hydraulic cylinder 13 operates under liquid pressure to withdraw the rod 14, thus pivoting open the cover 4. The curtain 6 falls down to the floor 2 under its own weight.

Simultaneously, a mixture of water and a foaming agent is supplied through the blowoff pipes 25 to the bubblers 19 which blow foam into the diffusion chambers 24. The foam overflows them from their open

ends, and through the perforations 28, filling the space on the horizontal plate 9. Then, it overflows the guide plate 10 and flows down through the slit 12 into between two nets. It flows down therebetween and on their surfaces in a sufficient amount to cover substantially the entire width of the curtain 6 to make it gastight, thereby preventing flame and smoke from spreading to other sections of the room or passage. After the fire has been extinguished, the curtain 6 can be rolled up into its original position by means of the winding drum 30.

Although in the preferred embodiment a combination of smoke and heat sensors and a solenoid valve is adopted, known automatic sprinklers may be used instead. In case of fire, the automatic sprinkler operates to sprinkle the section. Accordingly, the pressure in the upper chamber 36 sinks so that the differential valve 31 opens. The hydraulic cylinder 13 may also be replaced by an electromagnet directly connected to the smoke and heat sensors 42 and 43.

The curtain 6 may or may not be provided with cuts extending from its bottom up to a suitable height to further facilitate the escape of persons left behind.

In the second embodiment shown in Fig. 7 the curtain 6 is constituted by a single net (or coarse cloth), the upper end of which is attached to the inner end of the plate 9. To the upper portion and at the bottom of the curtain is attached a steel weight bar 45 covered with a soft material, such as rubber. The upper weight bar is suspended by a plurality of ropes 44 which are of such a length that when the curtain 6 falls, it will slope above the upper weight bar 45. Foam flows down the slope thus formed and then the vertical portion of the curtain.

If this system is applied for fire prevention in a wide room, a plurality of the curtains can be arranged in a checkered pattern to divide the room into several sections. For each section, a smoke sensor, a heat sensor, a solenoid valve and an automatic valve are provided. Should a fire occur in any one of the sections, all the curtains serving for the section fall down simultaneously to isolate it from the neighbouring sections.

If this system is installed in a passage, the curtains can be arranged thereacross at a suitable distance to divide it into a plurality of sections. In case of fire, the curtains provided on each end of the fire starting section fall to isolate it.

If it is installed in an underground shopping street, a curtain may be provided over the doorway to each shop. If a single duct connects the shops with one another, the curtains may be mounted in the duct to prevent flame and smoke from running therethrough.

Although the present invention has been described above mainly in connection with fire prevention, it can be applied in tunnels for motorways, subway and railway, passages in coal mines, and the like, to shut smoke or harmful gas in a restricted place. A fire extinguishing method using halogenated gas, carbon dioxide gas or the like has frequently been used. Some of such gases are expensive and others are detrimental to the human body. A combination of the present flame and smoke containment system with such a fire extinguishing method makes it possible to minimize the consumption of an expensive gas and greatly lessen the chance of any person left behind inhaling harmful gas, as might be the case when only gas is used in an isolated place.

It will be readily understood that the flame and smoke containment system according to the present invention effectively checks the spread of flame and smoke to neighboring areas, thereby greatly facilitating fire extinguishing and escape from the spot where a fire started. Unlike the conventional metal fire shutters and doors which were hard to open quickly once closed, the fire curtain used in this invention can be easily tucked up to escape to safer places because of its light weight and flexibility.

Furthermore, the conventional fire shutter and door hardly transmit light. Should power failure occur after they have been closed, the isolated area would be blacked out, making escape more difficult. On the contrary, the fire curtain used in this invention has the advantage of transmitting a sufficient amount of light from neighboring areas even if power should fail.

Also, even if explosion should occur in the isolated section, it would not lead to a serious damage because the curtains are easily deflected up by a blast.

WHAT I CLAIM IS:—

1. A flame and smoke containment system for use in a room having a floor and a ceiling comprising: a container adapted to be mounted on the ceiling and provided with a cover pivotally mounted at the bottom thereof, a curtain normally stored in said container so as to hang from the ceiling when said cover is opened and being of a sufficient length to reach the floor and of a sufficient width to cover the entire width of a section in which to contain the flame and smoke, said curtain being constituted by a net or cloth made of non-inflammable material, foaming means for causing foam to flow down said curtain, detecting means responsive to heat

or smoke, means for opening said cover in response to the operation of said detecting means, whereby letting fall said curtain, and a normally closed valve adapted to open in response to the operation of said detecting means, and to allow a liquid to flow to said foam producing means to cause the latter to produce foam.

2. A system according to claim 1, wherein said curtain is constituted by at least two nets or cloths.

3. A system according to claim 1 or 2, wherein said detecting means include an electrical heat sensor and a smoke sensor.

4. A system according to claim 1 or 2 wherein said detecting means is an automatic sprinkler.

5. A system according to any one of the preceding claims wherein said cover opening means is a hydraulic cylinder.

6. A system according to any one of claims 1 to 4 wherein said cover opening means is an electromagnet.

7. A system according to claim 1 or 2 wherein said foam is a mixture of water and a foaming agent.

8. A flame and smoke containment system substantially as hereinbefore described with reference to the accompanying drawings.

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FIG 1

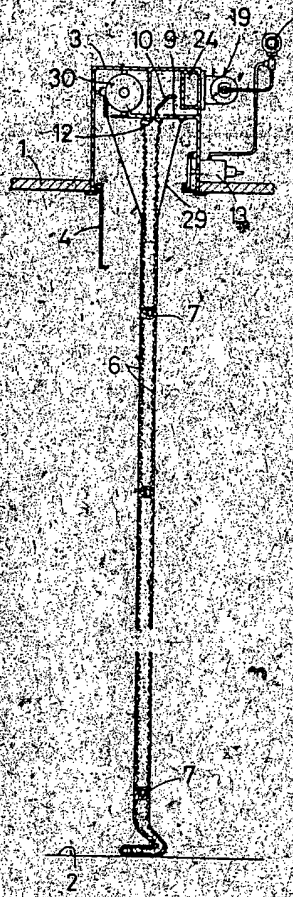

FIG. 7

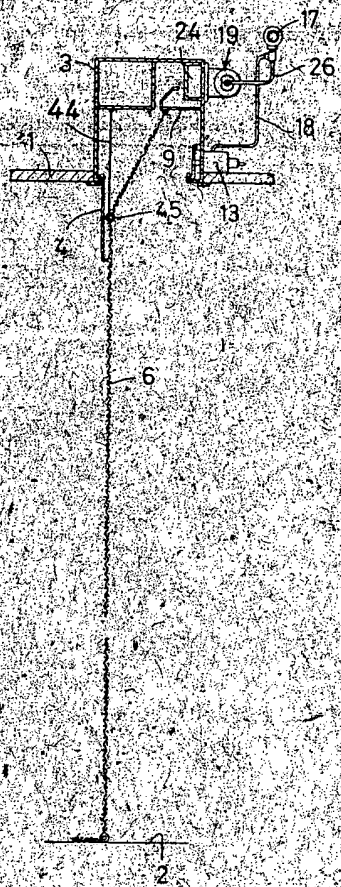

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FIG 2

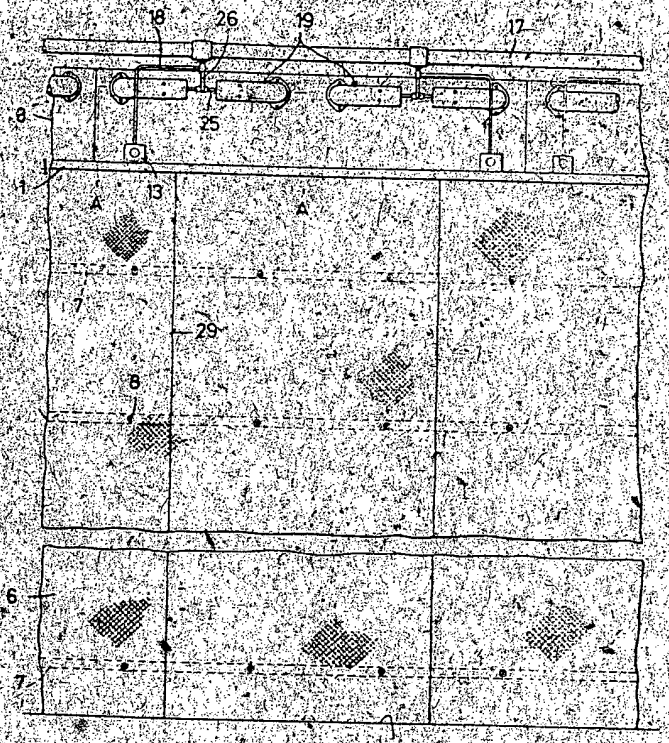

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FIG 3

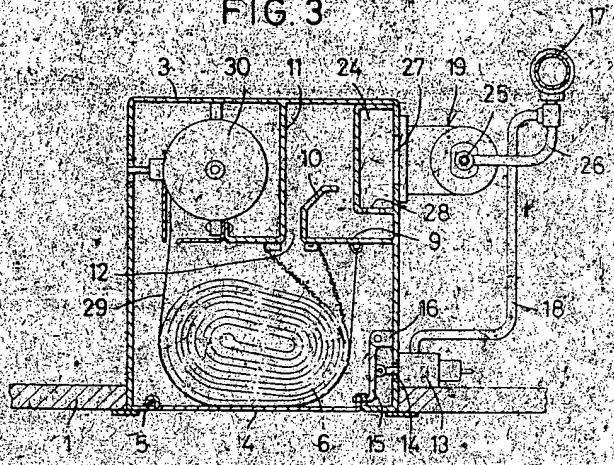

FIG 4

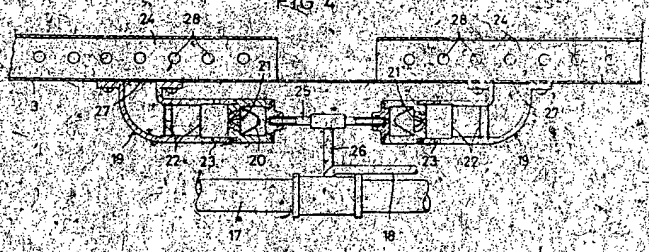

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FIG 5

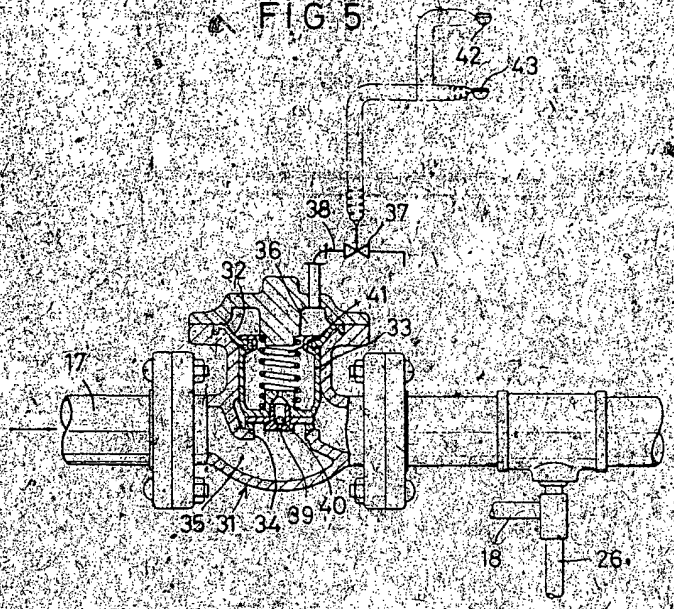

FIG 6